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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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THE ROYAL ASTRONOMICAL SOCIETY
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POPULARIZING ASTRONOMY

By H. Boyd Brydon

"How long will the inhabitants of this planet continue to live in ignorance of where they are and without appreciating the marvels of the Universe?"—Mme. G. Camille Flammarion."

THE Royal Astronomical Society of Canada has centres in nine cities. The combined population of these nine cities is about 2,400.000; some 23.4 per cent. of the total population of Canada.

Is it making an extravagantly large guess to say that of these 2,400,000 there are at least 100,000 who are more or less interested in astronomy? Well, as those less interested may largely outnumber those more interested, let us make one more guess; that the more interested number only 20,000. If this guess be about right, and it can hardly be set much lower I think, then it may be taken not unfairly as a low estimate of the possible membership of this Society whose doors are open to all interested in astronomy.

What proportion of this possible membership is actual? Less than five per cent.! There is our challenge, our problem. What are we going to do about it?

Undoubtedly it will be asserted that this estimate is foolishly high. It will be pointed out that no scientific society, not even a society of the type of the Royal Astronomical Society of Canada has such a proportion of the population in its membership as is here suggested. Let that be granted. What is it but an admission of failure? What does it show except that as a body our Society fails to attract those who should be members; that there is something woefully lacking in the way we present astronomy to the general public? "The fault, dear Brutus, is not in our stars, but in ourselves."

Of course, it may be held that although its membership is open to all interested in astronomy, the Society is under no obligation to take any active measures to induce them to become members. That view however does not promote the well-being of the Society nor increase its membership. Without such increase there is stagnation, and stagnation is a form of death.

It may not unfairly be considered also that the Society owes a duty to the people of Canada to lend its authority to combat, at least by published expression, the so-called astrological pronouncements and "horoscopes" appearing daily in our newspapers. That they are believed by many is undeniable. That they do much harm is inevitable.

Speaking of astrology calls to mind an amusing incident related by Prof. W. H. White of the University of London in his delightful description of the Royal Astronomical Society tour across America in 1932. " 'Keep this party all together,' said the agent at Seattle to the Pullman attendant, 'they are the Royal Astrologers'."

The Society's financial statements tell the story and point the way:—the desirability, nay, the necessity of an extensive popularization of astronomy. It is common knowledge that a certain expenditure is necessary to keep any concern going, whether it is doing any business or not. That expense may be termed its fixed cost. The additional cost of making and disposing of its product is substantially proportional to the number of units of product made and disposed of. It results that the larger the output the smaller the cost per unit. This is true whether the business is generating electricity, growing potatoes or running a learned society.

The Royal Astronomical Society of Canada was originated by amateurs and is fundamentally a society of and for amateurs. It is honoured by having in its ranks many eminent professional astronomers. Indeed it owes an inestimable debt to them. Without their help and guidance it is doubtful whether the Society could have reached even its present status. But it remains for the amateurs, those members "interested in astronomy", to make it the cultural force in Canadian life that it should be.

It may be admitted at once that such interest as the layman may have in astronomy is largely passive and will remain passive and the Society will be the loser unless the means of arousing,

nurturing and satisfying his interest are brought directly, effectively and attractively into action. That is the Society's job.

These ideas have occupied the attention and guided the efforts of the executive officers of Victoria Centre for several years. A measure of success is attending these efforts. The thought that its experience may be of use to other Centres whose officers may be engaged with similar problems prompts this paper. It is hoped that similar papers may be contributed from other Centres. Of course, what is said here is simply the result of observation at this one Centre. Conditions elsewhere may lead to other conclusions.

On September 21 last an extremely interesting and, as may be surmised from its title, "The Atmosphere of a Star,"—rather technical paper was presented by Dr. R. O. Redman, Assistant Director of the Solar Physics Observatory at Cambridge, before an audience of over one hundred whose interest and appreciation were very evident. An educator of note attending this meeting subsequently remarked on the large number of young people in the audience and on the intelligent interest shown by them.

That is one result of the formation of the class of Junior Members by this Centre in 1931. Until the age of 21, membership dues at this Centre are one-half of the regular dues. These Junior Members have all the privileges of the Society except the right to vote. The Centre receives no grant from Headquarters on account of the dues paid by these Junior Members. The General Society consequently profits equally from them as from the full members. It has not found it possible however to recognize these Junior Members officially as such. Why is not clear. For as the years pass many of these Juniors will graduate into full membership and ultimately form the body from which the executives are drawn. If the Society is to flourish, there must be a continuing influx of youth and the enthusiasm of youth. The Society must make its activities sufficiently interesting and attractive to promote this influx and encourage these Juniors to retain their membership. Some other ideas which have proved useful at Victoria Centre are discussed below.

Following the practice of most Societies this Centre furnishes each member on payment of dues an annual membership card.

It serves as an identification and is of value as an introduction. The cost is trifling.

The number and frequency of meetings has had consideration. After trial of sessions consisting of six fortnightly, four monthly and five tri-weekly meetings, the last has been found to work out best at Victoria, all things considered, at least for the present. But it is not enough to hold four or five meetings "open free to the public" each spring and autumn, with one or two so-called "observation meetings" thrown in during the summer and expect much response. Certainly financial deficits seem to be a continual threat under such a regime. The situation can only be met by increased membership, which means increased attractiveness.

During the past three summers Victoria Centre has held extra series of meetings designed to attract outsiders, remove their fears of the difficulties of astronomy and lead them to become members. In general each meeting comprised a thirty-minute talk on some astronomical subject followed by pointing out the constellations in the sky, "constellation study", and viewing some of the more striking objects with the telescope. From the reports published in the JOURNAL it will be seen that these meetings fairly achieved their object. Experience gained in 1932 and '33 was most useful in planning last year's programme. First, instead of calling it a "Summer Lecture Course in Astronomy," the name was changed to "Summer Evenings with the Stars." It meant much the same thing but the psychological appeal was very different. Next, the titles of several of the "talks", not "lectures", were put in the form of questions; such questions as one is commonly asked when the subject of astronomy is brought up in conversation. The result was the following programme:—

ROYAL ASTRONOMICAL SOCIETY OF CANADA
(VICTORIA CENTRE)

Everyone wants to know something about the stars but most of us have neither the time nor inclination to wade through books on astronomy which are often too dry and too technical to be read with pleasure.

To meet this want the Royal Astronomical Society of Canada (Victoria Centre) is holding another series of those enjoyable "Summer Evenings with the Stars" which have proved so popular in recent years.

On each evening a short talk will be given in plain, every-day language, on the subjects mentioned in the following programme:

PROGRAMME

July 9—Astronomy as a Recreation.....H. BOYD BRYDON (*President*)
" 16—What is a Star?.....C. S. BEALS, PH.D.
" 23—How Big are the Stars? How Far Away are They? } .....W. E. HARPER, M.A.
" 30—Stellar Evolution.....J. A. PEARCE, PH.D.
Aug. 6—Some Peculiar Stars.....HELEN S. HOGG, PH.D.
" 13—The Sun.....GORDON SHAW, OPT.D.
" 20—The Moon.....P. H. HUGHES, MUS.BAC.
" 27—The Earth.....LIEUT.-COMM. H. R. TINGLEY, R.C.N.
Sept. 3—The Other Planets.....G. BROWN-CAVE
" 10—How Did the Solar System Come About?...CHARLES HARTLEY, M.A.

After each talk the story of one of the conspicuous groups of stars, the constellations, will be told, its place and its principal stars pointed out in the sky and interesting facts given concerning them by Mr. Robert Peters. Each evening will be concluded by observing some interesting object with the telescopes made by amateur members of the Society.

Mathematics and a costly telescope are NOT necessary to enjoy the stars. Bring your opera or field glasses with you and see for yourself how many splendours of the heavens you can see with them when you know where to look.

A set of four sky maps showing the stars in their seasons will be a great help in this connection and will be given to all attending the series.

Members of the Society will be admitted to this Summer Course, free of charge, on presentation of their membership cards. A charge of One Dollar will be made to non-members attending the same. Tickets for non-members may be secured from the Secretary of the Centre, Horace E. Moore, Metropolis Hotel, Yates Street, Victoria (G-7187). Early application is requested.

Through the kindness of the Board of School Trustees, the meetings will be held in the Laboratory and grounds of Victoria College.

June 27th, 1934.

The talks were illustrated by blackboard sketches, models and lantern slides. A remarkable tribute to the speakers was the really free discussion that followed the talks. Adjournment was then taken to the open, where two, and occasionally three, telescopes were set up. This part of the programme was splendidly managed by Mr. Robert Peters, ably assisted by Miss Phoebe Riddle, whose accurate knowledge of the constellations was also most valuable.

Preliminary announcements for these meetings were better arranged than in previous years. In this the local newspapers kindly gave much useful publicity. About one month before the first meeting, short paragraphs were published stating that the

programme for the summer meetings "which had proved so popular in recent years" was well in hand and would be announced shortly. These were followed by publication of the programme itself. Next, the big editions, the Saturday evening edition of the *Times* and the Sunday morning edition of the *Colonist* carried articles on "Astronomy as a Hobby". These were followed by two talks broadcast over Radio Station CFCT, which generously lent its facilities for the purpose.

Now for results. The following table gives the attendance figures for the ten meetings:—

July 6, 33; July 16, 38; July 23, 45; July 30, 48; Aug. 6, 53; Aug. 13, 57; Aug. 20, 81; Aug. 27, 64; Sept. 3, 34 (Labour Day); Sept. 10, 62.

Each of the meetings was admirably reported by the newspapers and the increasing attendance throughout the series was undoubtedly due in part to these reports.

Of the non-members attending, 17 applied for membership and were elected on Sept. 21, a record, I am informed, for this Centre, increasing its membership by some 14 per cent. Altogether this summer series was an unqualified success.

Mention was made of the telescopes used during this summer series: two were 3-in. altazimuth refractors, the third an 8-in. equatorially mounted reflector made by Messrs. R. & L. Hopkins, members; its performance on the temporary mount was good.

Early last autumn, at the suggestion of Mr. W. R. Hobday, who was promptly appointed chairman, a telescope-making section was formed. Seven 6½-in. reflectors are coming through, three of which are completed. A 9½-in. mirror is nearly finished. While the mountings of some of these telescopes will be very simple, an equatorial mount, gravity driven, with slow motions controlled from the eye-piece has been designed and is being built. Simplicity, rigidity, convenience and low cost were essentials. A feature is the use of "meccano" gears in the slow motions and the design is arranged so that these motions can be added as one's funds permit. It is hoped to submit shortly for publication a description of this mounting.

Under Mr. Hobday's supervision also an exhibit of three of these telescopes, together with a demonstration by him of mirror grinding,

was arranged in the B.C. Provincial Fair. An excellent feature of this exhibit showed the several grades of abrasive used in grinding a mirror with a set of 3-in. diameter glasses showing the condition of the glass surface resulting from the proper use of each grade. The exhibit attracted much attention. Mr. Hobday, Dr. Gordon Shaw, and Messrs. R. & L. Hopkins in addition to lending their telescopes, gave much of their time and energy in preparing and setting up the exhibit. These men worked.

Mr. W. E. Harper, Assistant Director of the Dominion Astrophysical Observatory, kindly demonstrated to the section the method of preparing and handling the silvering solutions which his long experience had proved desirable. This was a real help.

Indeed much of the success of the year's activities at Victoria has been due to the cordial co-operation of the staff of the Observatory. In this respect Victoria Centre is most happily situated and this opportunity is welcomed to acknowledge the pleasant relations existing and the advice and assistance that have been willingly afforded. Not the least of these has been a series of twelve weekly talks on practical astronomy and computing given during this spring by Dr. J. A. Pearce. Attendance was not large but made up for the lack of numbers by its enthusiasm. The Centre owes Dr. Pearce a special debt of thanks for his fine spirit of helpfulness and encouragement at all times.

This year our library, which previously had been rather inaccessible notwithstanding the efforts of its curator, Mr. W. T. Bridge, was removed to our regular meeting-place and Miss Mira Oliphant was appointed Librarian. With Miss Jorga Eek assisting, Miss Oliphant has prepared a complete card catalogue of the library and established a definite system for borrowings. The change has greatly increased the use of the library.

The library is greatly in need of additions. Miss Oliphant would welcome presentations from our members and would be glad to suggest suitable works.

Why could not the library at Headquarters go through its shelves and present to those Centres requesting them such duplicate copies as it may have? In this connection also, were the catalogue of the Headquarters Library mimeographed or printed and copies

sent to each Centre for reference, that library would be far more useful than it is.

To sum up. The Society needs a much larger membership. This can be achieved only by making astronomy attractive, by giving people something to do as a splendid hobby.

The General Council could do much to help but except for its grant each Centre is left to work out its problems by itself. Vision, enthusiasm, and a definite programme are needed but no programme has been published. As someone well said, "Nothing we do is without mistake but the greatest mistake is to do nothing." In many years there has not been such a general interest in astronomy as there is to-day. Hundreds of telescopes are being made, telescopes that can do useful work in properly guided hands. The A.A.V.S.O. is doing much in this respect. What is the R.A.S.C. doing? What is it going to do in 1935? Perhaps the members of the General Council will take the lead in a campaign to extend and improve the work of the Society. Privates may win battles but they do not plan them. That is the duty of their officers.

Meanwhile out of a potential membership of at least 20,000, our actual membership, including those resident abroad, is around 900. What are we going to do about it?

THE NEW STAR IN HERCULES

By W. E. Harper

THROUGH some slip the usual Harvard telegram of discovery failed to reach us and it was not until a notice appeared in the local press of December 19, 1934, that we were aware of a nova being in the sky. The next day the announcement card from Harvard gave the position.

Spectra were secured by Beals on December 21, by Harper on December 24, and by Pearce on January 9 of this year. All plates were made in the evening hours. Unfortunately, our secondary mirror was away in Pasadena being aluminized and we had to be content with the ultra-violet spectrograph attached at the prime focus. At λ5160 the dispersion of this instrument is about 236, at λ3305 about 35, while at the interesting *H* and *K* region it is of the order of 100 A. per mm. It is thus not a satisfactory instrument to use on the nova, at least in the bright stages.

Rough estimates of magnitude were made by comparing the nova with gamma Draconis, magnitude 2.4, and with beta Draconis, magnitude 3.0. On December 24 it was about 2.7, on the 27th it was 2.4, and on January 6th it seemed definitely brighter than gamma Draconis and was set down as 2.2. Fleeting clouds may have vitiated this last result but steady watching for five minutes showed it always brighter than gamma.

The spectrum is markedly different on the three nights. On December 21st the Balmer lines from *Hβ* to the head of the series at λ3646 stand out prominently on a strong continuous background. Seventeen such lines were counted and practically all were measured. The *H* and *K* lines of ionized calcium are also present in about the same strength as the hydrogen lines. From λ3600 or thereabouts to below λ3300 there are other absorption lines, the greater number of which have been identified with ionized titanium.

The spectrum of December 24 has the continuous spectrum crossed by wide absorption bands. Such a band starts sharply about λ4210 and fades off gradually to near λ4000. Another begins about λ3876 (is it cyanogen?) and fades off about λ3756, while a

third has its head about λ3590 and fades off about λ3483. In addition to these marked bands the *H* and *K* lines of ionized calcium are greatly strengthened from the previous plate. The Balmer series is barely noticeable but the ionized titanium is much the same. Four lines measured at λλ3627, 3681, 3756 and 3876 are greatly increased in intensity over those of the 21st. The normal wave-lengths of these would, of course, be about four angstroms greater.

In the spectrum of January 9, a P Cygni type of spectrum is one's first impression. Pronounced, though fairly narrow, emission shows in the spectrum from around λ3300 to λ5200, the emission lines being bordered by absorption on their violet edges. The hydrogen series, the *H* and *K* lines, ionized titanium and ionized iron (λ4924 and λ5018 are striking) all contribute to the display.

Since no tables existed for this ultra-violet spectrograph it has been necessary to compute constants and reduce each plate separately to obtain the wave-lengths. Not all the lines have as yet been identified but the list of lines of the elements as prepared by Charlotte E. Moore and issued as a *Contribution* from Princeton, has been found most helpful in identification. The preliminary announcement card stated the displacements of the lines to be of the order of −170 km. per sec. From 24 lines of 45 measured on a plate of the 21st the velocity was found to be −220. This increased to −280 on the 24th for the lines in general, while *H* and *K* seemed to be 100 km. even more negative. This increasing velocity of approach is shown by the third plate, the *H* and *K* lines showing −490 with the general lines having the same order of displacement.

This treatment is merely preliminary. Our secondary mirror is expected back soon and then more suitable dispersion can be used in the investigation. I am indebted to Dr. Pearce and Dr. Beals for allowing me to use their plates in this preliminary note.

Dominion Astrophysical Observatory,
Victoria, B.C., January 12, 1935.

THE ABSORPTION BANDS IN THE SPECTRA OF THE OUTER PLANETS*

By Henry Norris Russell

JUPITER shows a conspicuous band in the orange, which was discovered visually by Huggins in the early days of spectroscopy, and fainter ones in the green. These appear more strongly in Saturn, but only in the spectrum of the ball of the planet, and not at all in that of the ring—which might be anticipated, since the ring consists of a multitude of tiny isolated satellites, and should be quite devoid of atmosphere. Uranus, though its light is faint, shows the same bands, much more strongly, and many others in addition. One of these, which closely coincides with the *F* line of hydrogen (λ4861) led Huggins to conclude that the planet's atmosphere was rich in hydrogen.

This interpretation, though quite permissible at the time, was erroneous, for the line is absorbed only by disassociated *atoms* of hydrogen, which will not be present except at very high temperatures.

The bands cut out so much of the red and orange light that the whole disc of Uranus appears decidedly green—an unusual colour, noticed from the time of the planet's discovery.

In Neptune's spectrum, the bands are of enormous strength, cutting out the red almost entirely and making the planet look still greener. They are hard to observe visually in so faint an object, and the full realization of their intensity came only with the admirable photographs of V. M. Slipher, in 1907. In later years, and with modern plates, Slipher has extended his observations far into the red, finding bands of ever-increasing strength—up to λ10,000 for Jupiter, where there is light enough to follow the spectrum farthest.

For more than sixty years after their first discovery, and twenty-five after Slipher's spectrograms, these bands presented one of the

*From the address of the retiring president of the American Association for the Advancement of Science, Pittsburgh, Dec 31, 1934. The entire address, which bears the title, "The Atmospheres of the Planets," appears in *Science*, Jan. 4, 1935.

principal unsolved puzzles of spectroscopy—for no one had duplicated them in the laboratory. To be sure, one group, near λ7200, agrees fairly well with a band of water-vapour—but the still stronger water-vapour bands deeper in the red are absent, so that this must be a chance coincidence.

When the radiometric measures of Coblentz and Lampland, and of Nicholson and Pettit, showed that the temperature of the visible surfaces of Jupiter and Saturn must be well below −100°C.—while Uranus and Neptune are doubtless colder—the range of possibilities was very much narrowed. But it was not until 1932 that a young and brilliant German physicist, Rupert Wildt, realized the solution of the problem.

Other gases, like water-vapour and carbon dioxide, have strong fundamental absorptions in the infra-red, and fainter harmonics in the more accessible part of the spectrum, which demand a long absorbing path in the laboratory to bring them out. Utilizing observations of this sort, Wildt showed that certain bands in the spectrum of Jupiter near λ6470 and λ7920 agreed with those of ammonia, and others, at λ6190, λ7260 and λ8860, with bands of methane. The original comparison was not quite conclusive, for with the moderate dispersion then employed the planetary bands had not been adequately resolved into their component lines. This was soon accomplished by Dunham, who found so complete a coincidence of the accurately measured individual lines that both identifications were put beyond all question. For ammonia more than 60 lines were found to agree, and for methane 18 lines in part of one band. Some expected band lines were naturally blended with solar lines, but not one of importance failed to appear.

From these comparisons Dunham estimates that the quantity of ammonia gas above the visible surface of Jupiter is equivalent to a layer 10 metres thick under standard conditions. In Saturn it is less.

The climax of the tale came this year (1934), when Adel and Slipher announced that practically all the bands had been identified, and were due to methane. The 45-metre path and the 40-atmosphere pressure got enough of the gas into the way of the light to produce bands intermediate in intensity between those of Jupiter and Saturn. At this high pressure the lines flowed together, and

produced diffuse bands; but the agreement of these with the planetary bands was so complete as to be decisive.

A further, and wholly conclusive, test could be added. The fundamental frequencies of vibration of the methane molecule was already known, from observations in the infra-red. For the higher harmonics of these vibrations the frequencies are not exact multiples of the lowest, but nevertheless bear a simple numerical relation to them (as is well known in the case of other gases). Applying this test, the strongest bands (including Huggins' band in the orange, and the one coincident with the blue hydrogen line) were found to be harmonics, from the third to the eighth, of one of the fundamental frequencies, while another slower vibration was represented by all its harmonics from the eighth to the sixteenth. The remaining bands were accounted for by the combinations of these harmonics with other known frequencies, all of types consistent with the well-established rules which govern band spectra. Thirty-six bands in all have been identified. Many of these appear only in Uranus and Neptune, and have not yet been produced in the laboratory, but the harmonic relation just mentioned make their identification certain. The higher gaseous hydrocarbons, ethane, ethylene and acetylene, all have bands in places clear of disturbance by the methane; and all were looked for in vain. All the planetary bands of any importance are accounted for by methane alone—it is a clean sweep.

From the published data, it appears that the amount of methane above the visible surface of Jupiter is of the order of one mile-atmosphere. There must be much more on Uranus, and especially on Neptune; but we can not yet estimate its amount.

NEW LABORATORY DETERMINATIONS OF THE SILICON LINES

J. A. Pearce

The observers of stellar radial velocities are again indebted to Prof. Fowler and his associates at the Imperial College of Science for accurate laboratory wave-lengths of the lines used as standards for the radial velocities of the high temperatures stars. A very accurate interferometric determination of the wave-lengths of the silicon lines has recently been made by C. V. Jackson[1], using the secondary standards of krypton as comparison, instead of the iron standards, as formerly used. The results are accurate to ±0.001A and Jackson's values for the three stages of ionized silicon should replace those of Fowler[2] and Barrell[3] in the table of Velocity Standards in the O and B type Stars, compiled by the writer[4], and adopted by the sub-committee on wave-lengths at the last meeting of the International Astronomical Union[5].

The spectrum of silicon is very important astrophysically, as the lines of three stages of ionization occur in the spectra of the high temperature stars. A doublet of SiII, I.P. = 16.27 V, is usually observed in the A5-B5 stars; the triplet of SiIII, I.P. = 31.66 V, occur in types B3-B1; while the doublet of SiIV, I.P. = 44.95 V, are important lines from B0-O6, being used, not only for radial Velocities, but as criteria for classification. It is not uncommon to observe two stages of ionization within the same spectrum, and few O or B class spectra fail to show some silicon lines. They are of uniformly good quality for measurement, and have been used in radial velocity determinations from the pioneer work of Frost and Adams in 1902 to the present.

The need for accurate laboratory values, particularly of the SiIII lines was emphasised by Albrecht[6] as long ago as 1911. The early laboratory determinations of Exner and Haschek[7] and later Frost and Brown[8], were used by observers of this period. These were superseded by the accurate work of Barrell[3] in 1923, who determined the wave-lengths concerned with an accuracy of ±0.002A

from grating plates in Fowler's laboratory, using the iron standards as comparison. The writer used Barrell's values in all his work from 1924-1930. Fowler[2] in his complete study of the silicon spectrum, Bakerian Lecture 1924, adopted Barrell's values for SiII and SiIV, but substituted other values for SiIII, in general 0.044A longer than those of Barrell. The Fowler values have been used at Victoria from Sept. 1930 to Sept. 1934, although Albrecht[9] has shown that his stellar values agree better with the earlier Barrell, than the later Fowler wave-lengths.

The laboratory values are given in the table below, together with the stellar values in Albrecht.

LABORATORY AND STELLAR VALUES

	Barrell	Fowler	Jackson	Albrecht
Si IV I.A.	4088.863	.863	.862	
IV	4116.104	.104	.103	
Si II	4128.053	.053	.051	
II	4130.884	.884	.876	
Si III	4552.611	.654	.622	.612
III	4567.824	.872	.841	.823
III	4574.737	.777	.758	.756

RESIDUALS

λ	*J-B*	*J-F*	*B-F*	*J-A*
4552	+0.011	−0.032	−0.043	+0.010
4567	+0.017	−0.031	−0.048	+0.018
4574	+0.021	−0.019	−0.040	+0.002
Δ =	+0.0163A	−0.0273A	−0.0437A	+0.010A
Δ =	+1.07 km./sec.	−1.79 km./sec.	−2.87 km./sec.	+0.66 km./sec.

The determinations of Jackson and Barrell for the SiII and SiIV lines are in excellent agreement, the mean difference being — 0.003A, corresponding to —0.02 km./sec. The differences between the three observers for the SiIII triplet, however, are so large as to question the value of these lines as stellar standards. The lines themselves are sharp and amenable to accurate measurement. The lack of agreement in the older values of Exner and Haschek, Frost and Brown, was attributed by Albrecht to impurities in the

electrodes, but the difference may more probably be ascribed, as Jackson suggests, to the difficulties of interpolation against the iron standards which are poor and too widely spaced in this part of the spectrum. This appears to be the only explanation for the large differences between Barrell and Fowler and the reason why Jackson used krypton as comparison.

It is apparent from the residuals above that the stellar values of Albrecht are in better agreement with Jackson than either Barrell or Fowler.

Unquestionably the recent determinations of the silicon wave-lengths are superior to all earlier values. It is desirable that the new values replace the older ones in the table of laboratory wave-lengths suitable as velocity standards for the stellar radial velocities of O and B class stars. Their adoption is recommended to all observers of radial velocities and to the sub-committee on wave-lengths of Commission 30, I.A.U.

Victoria, B.C.
October 1st, 1934.

REFERENCES

(1). C. V. Jackson, M.N., vol. 94, p. 723, 1934.
(2). A. Fowler, Phil Trans Roy Soc. A., vol. 225, p. 1, 1924.
(3). H. Barrell, M.N., vol. 83, p. 322, 1923.
(4). J. A. Pearce, J.R.A.S.C., vol. 26, p. 262, 1932.
(5). Trans. I. A. U., vol. 4, p. 187, 1932.
(6). S. Albrecht, A.A.S., vol. II, p. 71, 1911.
(7). Exner and Haschek, Ap. J., vol. 12, p. 49, 1900.
(8). Frost and Brown, Ap. J., vol. 22, p 159, 1905.
(9). S. Albrecht, A.A.S., vol. V, p. 282, 1925.

RADIO TALKS OVER CFCT, VICTORIA, B.C.

By W. E. Harper

No. 73.—NEW TELESCOPE MIRRORS.

(May 14, 1934)

My last three talks dealt with advances in astronomy during the past 75 years, each one treating a different phase of the subject. In speaking of the advances in instrumental equipment I showed why telescopes of the reflecting type have in recent years superseded the older refracting type in which the lens is at the outer end. The reason is, briefly, that it is impossible at present to cast disks of glass of the desired size which are perfectly free from imperfections such as air bubbles and striae. The largest one in existence of the old type is the 40-inch refractor of the Yerkes observatory near Chicago. A 41-inch, ordered some years ago by Russia from an English firm, has not materialized as yet.

In the original type of reflecting telescope "speculum" metal was used for the reflector. This metal was usually an alloy of copper and tin, which takes and retains a fine polish. Herschel's mirrors were of this type. But about 75 years ago it was discovered by Steinheil that a thin silver coating could be deposited chemically on glass and this, when polished, had a reflecting power nearly twice as great as that of the older speculum type. Moreover, in renewing the coat there was less danger of destroying the original figure of the mirror than in repolishing the speculum.

Up to a very recent date the silver-on-glass has been the universal type of reflecting surface used in these telescopes. Such has been the practice at our own observatory, the coat being renewed from time to time as required. In commercial work, of course, the coating is applied to the rear surface which is then covered by a special coating to protect the silver from the weather. Such protection is impossible where the silver deposit is made on the figured front surface and, of course, in time the mirror becomes stained and loses its brilliancy. While we are not much affected at our observatory

by the smoke and fumes from manufacturing establishments yet it is found necessary to renew the coating about twice a year.

This operation takes about a whole day, the mirror having to be detached from the telescope, the chemical solutions prepared, the old coating of silver removed and the new one chemically deposited. In our fifteen years' experience we have had only two serious failures and in both cases such could be traced to impure chemicals. It is considerable of a job, however, and moreover should be done even more frequently than we do it if the telescope is to be kept at its state of highest efficiency. It is readily understood, then, that if some more permanent coating of equal reflecting power could be found such would be a marked advance.

Laboratory studies upon the reflective power of metals had placed silver at the head of the list, with porcelain enamel, aluminium, chromium and nickel next in order. A few years ago I was shown a reflecting surface and asked to guess what it was. It was so brilliant I could not imagine it to be anything other than a silver coating, but was informed it was simply a piece of chromium steel, highly polished. Much investigation has taken place in recent days on substitutes for silver for this purpose and one has been found which bids fair to displace it entirely.

It is of a familiar composition, none less than the ordinary aluminium so much used in kitchen ware. We think of it as a greyish metal tarnishing readily and not one that would take a high polish. Two years ago when at the International Astronomical Meeting at Harvard, I was shown a mirror about fifteen inches in diameter which had been coated with chromium by Williams, a young student at Cornell, working under Professor Boothroyd, who spent a couple of summers with us here some years ago. Though battered around for several months, as he said, it still retained a high polish and we were all interested to learn of the process.

The technique has been improved since that time and aluminium is now found to be superior to chromium but the principle of making the deposit upon the surface by evaporation in a vacuum remains the same. The metal has a rather low boiling point and there is no trouble in volatilizing it, but the form in which it comes down depends upon vacuum conditions. In a partial vacuum it deposits

in a finely divided form as a dead black coating, but at the very lowest pressures the separate atoms from the heated filament condense on any clean surface and form a brilliant mirror. This coating immediately covers itself with an infinitesimally thin film of oxide and suffers no further change. This film can be washed with ordinary soap and water to clean off any dust and it is proof even against nitric acid which would dissolve the silver coating in the twinkling of an eye.

It thus has reflective qualities almost equal to silver with the added advantage of several times its permanency. But an additional argument in its favour is its ability to reflect light of the shorter wave lengths from 3000A. to 3600A. in which part of the spectrum a silver coating is almost useless to reflect the light. Thus with the new coatings we can study a region of solar and stellar spectra inaccessible to us hitherto.

The Mount Wilson Observatory has had all their smaller mirrors coated with the new process and find them exceedingly satisfactory. The work is done at the laboratories of the California Institute of Technology where a special vacuum apparatus has been developed. The Lick Observatory has had one of their mirrors similarly treated and it is hoped in the near future to have our own secondary mirrors likewise resurfaced, as the Institute has kindly offered to do the same.

Just how far the new process will affect commercial work remains to be seen. It is something whose possibilities commercial firms might well be alive to.

No. 74.—THE MILKY WAY.

(August 21, 1934)

In describing a few of the important star groups in a previous talk I closed with a reference to the hazy band of light which circles the heavens and which is popularly known as the Milky Way. This luminous belt of irregular width and outline which in the evenings at this season of the year lies in a general north-east to south-west direction cannot fail to be noticed on any clear, moonless night by those fortunate enough to be away from city lights. Its course

passes through Cygnus, or the Northern Cross, which at ten o'clock is about overhead, thence north-easterly past Cassiopeiae Perseus and Auriga, until it disappears on the horizon. South-westward from Cygnus it passes to the west of the bright star Altair in Aquila, thence enmeshes Sagittarius and Scorpio. The Milky Way cuts the celestial equator at an angle of about 63° and this plane of the Milky Way or galaxy is often used in statistical discussions of the stars, because towards it from both sides the stars seem to crowd as much as possible.

The Milky Way appearance is due to great numbers of faint stars, invisible to the naked eye but contributing by their combined light to the brightness of the apparently continuous background. In an earlier talk I told you how the fifty billions of stars which our telescopes reveal to us occupy space not in the form of a sphere but much like that of a thin watch or lens. With the solar system situated near the central plane we on the earth are looking through a greater depth of stars when we gaze in the direction of the Milky Way than when we look in a direction at right angles thereto. To repeat: the Milky Way is the suffused glow of millions upon millions of faint stars which we see when looking in the direction of the long diameter of the universe.

In a previous talk also I discussed the general illumination of the night sky and we learned that apart from moonlight or starlight there is a considerable illumination due (1) to what may be regarded as a permanent aurora and (2) to what is known as zodiacal light, the latter being sunlight reflected from very tiny particles out on the borders of our solar system. If these two sources of illumination were removed the background of the sky would be much blacker than it is and in consequence the Milky Way would stand out in contrast much more prominent than it now does. As it exists now the Milky Way regions are on the average twice as luminous as regions far removed from it but if the general illumination due to the two causes suggested were removed the Milky Way would be fully eight times as luminous as other portions of the sky 90° distant.

From earliest times myths and legends have abounded concerning it. The most popular notion of it among all people and in every age

has been to regard the Milky Way as a highway among the stars, a road to heaven traversed by the souls of the departed.

According to a French tale, the stars in the Milky Way are lights held by angel spirits to show mortals the way to heaven. The Algonquin Indians believed that this was the Path of Souls leading to villages in the sun. As the spirits travel along the pathway their blazing camp-fires may be seen as bright stars.

Thus in all ages and among all nations the galaxy has been likened mostly to a road or pathway to the land of the hereafter and this universal idea may have come from the fancy that the heavenly way, crowded with stars, resembled the earthly road crowded with pilgrims.

Speculation has always been rife as to its real nature. Aristotle thought it was a vast mass of glowing vapour far above the region of the ether and below that of the planets. Pythagoras had stated earlier that it was a vast assemblage of very distant stars, but we must regard his right conception of it as in the nature of a shrewd guess as it was not until the telescope was invented that the misty light was resolved into myriads of stars.

While the phenomenon of concentration of the stars towards the central plane of the galaxy can be noticed readily for the naked eye stars it becomes increasingly pronounced as we go to fainter and fainter stars. This is simply a result of the gradual thinning out of the stars in a direction at right angles to the plane of the galaxy. Probably at a distance of 1000 light-years from the central plane the star density has become so low that we may consider the contribution made by the more distant stars as of negligible amount. In the plane of the galaxy, however, we would have to go a distance probably twenty times as great before the star density would become correspondingly low. So that if we were considering all the stars within a sphere 1000 light-years in radius we would not notice any great variation in the numbers with direction in space but when we go farther out, and thus are dealing with fainter stars, the greater number in the plane of the Milky Way is forced upon our attention.

The Milky Way itself is not of uniform brightness, and indeed in many places is marked by dark patches. For about one-third of its length, from Cygnus to Centaurus, it is divided into two nearly

parallel streams by an irregular dark band, which band, however, is in itself brighter than some of the other parts of the luminous belt. Moreover, there are distinct dark patches right in the midst of a field which is densely studded with stars. When photographs first brought this to our attention it was suggested that possibly here was a region devoid of stars; but then, when the depth to which the stars extend was recalled, it was realized that if such were openings they must be in the nature of long tunnels, thousands of light years in length, pointed directly towards us. The absurdity of such an idea led Barnard to the conclusion that these dark patches were nothing less than dark nebulae occulting from view all the stars beyond it. With the increasing number of such cases brought to notice by long exposure photographs we are now convinced that such is the true explanation. This view is all the more easy of acceptance since it has now been learned that many of the bright nebulae would in reality be dark if they were not kindled into luminescence by a high temperature star in their neighbourhood. Of this, more anon. Let us study the Milky Way and prove the accuracy of Milton's description:

> "A broad and ample road whose dust is gold
> And pavement stars as stars to thee appear,
> Seen in the Galaxy, that Milky Way
> Which nightly as a circling zone thou seest
> Powdered with stars."

No. 75.—NEBULAE (I).

(September 18, 1934)

In closing my last monthly chat, which had to do with the Milky Way, I referred to certain dark markings which on first thought might be considered to be regions entirely devoid of stars. I want to follow up that line of thought by discussing these dark nebulae, as we now understand these curious dark markings to be.

The word nebula means simply a cloud and we shall begin by studying the luminous, rather than the dark, kind. These appear in the heavens intermingled with the stars as faint, hazy clouds of light, sometimes of great extent, sometimes so small that it is not easy to distinguish them from stars. Only two of them are visible

to the naked eye—the large irregular nebula in Orion surrounding the middle star in the sword and the spiral one in the constellation Andromeda. Many more can be seen with small telescopes but the majority are so faint that they can be studied only by photography.

There is no department of astronomy where the photographic plate holds such a decided advantage over visual observation as in the study of these objects. The nebulae, as just intimated, are not points of light like the stars but are luminous surfaces of greater or less extent and no optical device can make an extended surface appear brighter than it does to the unaided eye. The telescope will, it is true, collect more light than the naked eye but it will at the same time magnify the surface area in the same ratio so that the intensity of the light at any one point is no greater than before. Up to a certain point, therefore, a small telescope, by increasing the apparent size of the nebula without unduly diminishing its contrast with the surrounding sky, is helpful in discovery. We cannot hope, however, by the use of larger and more powerful telescopes to glimpse nebulae which are below this limit of visibility in small telescopes.

You ask me, then, what's the use of larger telescopes? It is through being able to substitute the photographic plate for the human eye and prolong the exposures for twenty, forty or even sixty hours so that the faint light of the nebula by a process of accumulation will eventually register itself on the plate. The machinery for driving modern telescopes is so accurately made that the photographic plate is always exposed to the same region of the sky throughout the entire exposure time. Since the large modern reflectors have entered the field in the past twenty years the number of these nebulae revealed by photography with long exposures is simply astounding. Even with only one hour's exposure, the number would be at least 300,000 over the whole sky, whereas with exposures of upwards of twenty hours the number would run into many millions.

There are many ways of classifying nebulae for they differ in form and substance, but we shall divide them first into two great groups, (1) those that belong to our own universe of stars, the galactic universe so-called, and (2) those which are outside our system, the extra-galactic nebulae. The former constitute only a very small percentage of the total number and will be discussed first.

It was the opinion of Herschel, the English astronomer who was the first to study these objects, that their fuzzy or cloud-like appearance was due to their being composed of innumerable stars situated at such great distances from us that their combined light came to us as a suffused glow. With increasingly powerful telescopes he felt such would eventually be resolved and stand revealed as aggregations of individual stars. His prophecy has been fulfilled almost completely for the extra-galactic nebulae, but a large number of those in our own galaxy are different. Their analyzed light, or spectra, show isolated, bright lines such as are produced by a rarefied gas. Of course Herschel could not be expected to know this as the spectroscope was a later invention than his day. For such nebulae as show bright-line spectra we can say, then, that they are really great clouds of the lighter gases in an extremely rarefied condition. The presence of hydrogen, helium and another unknown gas, designated nebulium for want of a better name, was attested by these tell-tale lines in the analyzed light.

In passing, we may say it is only a few years ago that the secret of nebulium was discovered. It was rightly guessed that in keeping with the other gases this substance, whatever it was, must also be light (*i.e.* not heavy). In the table of elementary substances such as hydrogen, helium, lithium, carbon, etc., there were no gaps to be filled up, *i.e,* there were no more light elements to be discovered, and thus it seemed that it must be one or more of those elements already known but in somewhat different guise owing to the peculiar rarefied condition in the nebula. The successful tracking down of the gas constitutes one of the romances of astronomy, or in reality of physics, for it was Bowen, a physicist, who showed that the gas was none other than common oxygen and nitrogen though in very unusual forms.

The term galactic nebulae is fitting by reason of the fact that these nebulae in our own stellar system seem to hug closely the plane of the Milky Way, or the so-called galactic plane. True, there are a few of the brighter and apparently larger ones which are some little distance removed but such distance is more apparent than real. The extra-galactic nebulae on the other hand seemingly avoid the Milky Way plane, so that by reason of the position in the sky, without re-

course to other tests, we could be fairly sure which nebulae were part and parcel of our own universe and which once were separated from our system by vast reaches of space.

To sum up so far: Nebulae are cloud-like heavenly bodies, the great majority of which are outside our own universe and which are simply aggregations of faint, distant stars. Long exposure photographs have shown that these are several millions in number. A limited number, however, are found in our own system and these are mostly gaseous in composition. They are composed of the lighter gases in an exceedingly tenuous or rarefied condition.

No. 76.—NEBULAE (II).

(October 16, 1934)

Continuing our study of those filmy cloudlike objects in the heavens which are known as the nebulae we learn that within our own galactic universe there is a very limited number, about 150 in all, which in a small telescope often resemble a faint, planetary disk. The larger number, however, may have any shape and are classed as irregular or diffuse nebulae. These latter vary in apparent size and brightness from tiny wisps, which can just be photographed with long exposures, to the great nebula in Orion, which covers an area apparently larger than the full moon and is visible to the unaided eye.

Many of these diffuse nebulae are associated with stars in such a way as to make it probable that they are really related to them. This was first proved in the case of the nebulosities in the Pleiades, the little group which is seen in the early autumn evenings in the eastern sky. In this little group, the brightest stars are enmeshed in nebulous wisps, not striking to the eye, but well brought out on photographs. The very appearance suggested that these clouds were lighted up in some way by the light of the stars and when, further, it was noted by Slipher in 1912 that the light of the clouds, when analyzed, showed a spectrum identical with that of the imbedded stars there was no reasonable doubt that there existed a physical connection between the two. The nebulous clouds of very fine particles

thus reflect the light of the imprisoned stars, at the same time dimming their brightness.

During the past twenty years nearly a hundred other diffuse nebulae have been examined and the evidence seems complete that in such cases these nebulae do not supply from within themselves the energy by which they shine, but get it from neighbouring stars.

The distances of such nebulae are of course substantially equal to those of the stars which illuminate them. In several cases these latter are known. The Pleiades are about 500 light-years away, the Orion nebula is 600 light-years, whilst others are as much as a few hundreds of thousands of light-years distant. The actual dimensions of such nebulosities must accordingly be exceedingly great. The Orion nebula has a real diameter of ten light-years while others are larger still.

By means of the spectroscope we can measure velocities directly towards or away from us, and by such means we learn that these nebulae are not at rest. They may be described as turbulent, some portions approaching, some receding, while the mass as a whole may be rotating.

Though these bodies are huge it is fairly certain that their densities must be exceedingly low, as indeed the narrow and sharp lines of their spectra would suggest. Even though the matter in the Orion nebula be sufficient to form a few hundred stars the volume of space occupied by such matter is so vast that there results a mean density less than that of the best vacuum we can produce in our laboratories.

Turning our attention now to the limited number of planetary nebulae, which are roundish and sharply defined, we find in these also a central star, known from its spectrum to be at a high temperature. In these objects the sizes, while smaller, are still enormous, the diameters being at least several hundred times that of the whole solar system.

There is some uncertainty yet as to the masses and densities of these planetary objects. The range in size is not greater than 1 to 100 so that there is a certain measure of uniformity amongst them. While their density is again lower than the best vacuum we can produce, it nevertheless is a little greater than in the case of the diffuse

nebulae. The individual masses are probably of the order of twenty or thirty times that of our sun.

While it was stated just now that these nebulae were roundish in form it would be more appropriate to say that many are more nearly elliptical. Their appearance on photographs, with one diameter longer than the other, suggested that possibly they were rotating about the short diameter. When the test was applied by means of the spectroscope such was actually found to be the case, but though the speeds of rotation are enormous to our earthly way of thinking the sizes of the nebulae are so great that a few thousands of years are required to make one complete rotation.

One of the best known planetaries is the "ring" nebula in Lyra, an object which is frequently shown to our summer visitors on Saturday evenings. In the show-case at the Observatory may be seen a very excellent photograph of this object showing the elliptical nebulosity with a star of magnitude 13 in the centre.

So far I have conveyed the impression that these nebulae are vast cloud-like formations of dust particles or gas molecules in an extremely tenuous condition, which are seen by reflected light originating in a neighboring star. That is only part of the story and is what happens when the star has only a moderate temperature. If the exciting star, however, be one of high temperature, as is the case in all the planetaries, then its radiations of short wave length in some way stir up the atoms of the gas which are present in the nebula to give out light of their own. In this case we shall have bright lines appearing in the spectrum, due to the elements hydrogen, helium and certain unusual forms of oxygen and nitrogen. We repeat, then, that if the temperature of the star is only moderate the nebula will shine by reflected light but if it is very high it will kindle the atoms into luminescence of their own.

This brings us to face the question as to what would happen if there were no star nearby. In that case the nebulous matter would reveal its presence only by blotting out or occulting the light of any stars behind it. In my radio talk of two months ago on The Milky Way I referred to the dark markings in it which at first were supposed to be regions devoid of stars but which Barnard concluded, from an exhaustive investigation, were simply obscuring nebulous

clouds. These dark nebulae like their luminous brethren are of varied forms. In the constellation Ophiuchus we have great lanes of nebulosity which mask out more or less completely all the stars behind it. In other regions the stars are not completely obliterated but only dimmed and one can trace the contour of the intervening cloud by its dimming effect on the starry background.

It would appear that the main obscuring agent in these dark nebulae is fine dust, the size of whose particles is of the order of one-millionth of an inch in diameter. The recognition of the existence of such occulting matter throughout space has made necessary a revision downward of some of the distances of the more distant heavenly bodies. It brings home to us also the idea that possibly the non-luminous matter in the universe may be comparable in mass with the luminous.

THE NEW OBSERVATORY AT PRINCETON UNIVERSITY*

By FRANK SCHLESINGER
(Director of the Yale Observatory)

THE period immediately following our civil war was one of great activity in telescope building and gave this country a high standing with regard to astronomical equipment that it has maintained ever since. It was during these years that the great refractors at Princeton (23-inch), Washington (26-inch) and the University of Virginia (26-inch) were erected, each of them for a time unsurpassed as to size and power and all of them the product of Alvan Clark's unprecedented skill in making great lenses. A good lens resembles a precious stone in never losing its value, and though its setting may be badly worn or otherwise out of date, the stone itself does not deteriorate. The three glasses we have mentioned, as well as some older ones, are still busily engaged in astronomical work, but almost all of them have been reset in modern mountings. This has just become true of the Princeton telescope. The gift of General Halstead, this instrument was erected in 1867 on land donated by Dr. Cortlandt van Rensselaer not far from the centre of the campus, a location that grew less and less advantageous as the university expanded, and more and more desirable from other academic points of view. Two years ago the trustees tore down the old observatory and erected in its place a handsome dormitory. The New Observatory, as it is now officially to be called, is in the centre of a large field east of Palmer Stadium far removed from the city's lights and other similar disturbances. Furthermore the trustees have given assurance (and such assurance is essential) that no buildings that could interfere with the work of the telescope will be erected within the extensive "observatory area".

Not only is the new location much better than the old, but the mechanical arrangements have been immeasurably improved. A new mounting and a new dome have been installed by J. W. Fecker

*From *Science*, November 20, 1934.

of Pittsburgh. The eye-end of a large telescope varies in its distance from the floor of the observatory, depending upon whether the object observed is high or low in the sky. To reach it in all its positions a glorified step-ladder was the best expedient that the early designers of such telescopes could provide. When the Lick Observatory was erected on Mount Hamilton in the late eighties this problem of reaching the telescope in all positions became acute on account of the great length of the tube. A distinguished amateur astronomer, A. A. Common, of London, England, suggested that the Lick Observatory floor be made movable in height like an elevator sixty feet in diameter. The expedient was adopted and proved so successful that it has been employed for almost all large telescopes erected or remounted since that time. Such a "rising floor" has been installed in the New Observatory at Princeton together with all the other mechanical improvements that modern practice has shown to be so conducive to rapid and accurate observation with one of these great engines of research. A novel feature of this telescope is an iris diaphragm in front of the lens, in principle like that on an ordinary camera. This will enable the observer to alter the effective aperture of the telescope at will.

The Princeton Observatory has had two distinct periods of fruitful activity. The first fell in the closing two decades of the last century when Charles Augustus Young pursued with such signal success his pioneer work in solar spectroscopy. The second began about a quarter of a century ago and is still in healthy progress. It was then that Raymond S. Dugan, who is in immediate charge of the telescope, began a remarkably careful and thorough investigation of stars that vary in their light. More than to any other single factor we owe to his persistence in adhering under unfavourable circumstances to his original programme our minute knowledge of eclipsing variables. It is a matter of satisfaction to all astronomers that he and his pupils are to continue this work under such vastly improved conditions.

In another field the observatory and the department of astronomy at Princeton have made a striking record. In spite of the difficulties of handling the old telescope or possibly because of them, the institution has sent out a steady flow of competent astronomers. These

include among others H. N. Russell, the eminent head of the department since 1912; J. Q. Stewart, also at Princeton; the late J. M. Poor, of Dartmouth; Daniel, at Allegheny; Joy and Dunham, at Mount Wilson; Shapley and Menzel, at Harvard; Kovalenko, at Swarthmore; Sitterley, at Wesleyan, and Bennett at Yale.

NOTES FROM THE DOMINION ASTROPHYSICAL OBSERVATORY

In continuation of the observing statistics from the September, 1934, issue of the JOURNAL, we have the following from the records of the observatory:

Month	1934		16-year average	
	Nights	Hours	Nights	Hours
July	22	115	24	129
August	23	152	24	147
September	22	165	20	146
October	14	104	16	123
November	7	33	12	78
December	5	25	9	63

The last two months of the year were very poor for observing; apart from that, the observing weather was about the average.

The number of visitors to the observatory for these six months was approximately 16,582, making the total for the year 21,608, as compared with 17,123 last year. Among visiting scientists may be mentioned Dr. Andrew McKellar, formerly a summer assistant, now of the Massachusetts Institute of Technology; Professor Lee of Dearborn Observatory; Dr. Stoy, a Commonwealth Fellow, temporarily at the Lick Observatory; and Dr. Jacobsen of the University of Washington. All gave interesting addresses to our Seminar Club. Professor Zwicky of Mt. Wilson also paid a brief visit to the observatory.

During the few days from the 22nd to the26th of August the weather was quite hot for Victoria, with the result that the fire hazard increased greatly. From an unknown cause a fire broke out on the main road passing the observatory property on the afternoon of August 24 and in a few minutes spread rapidly over the observatory property. The few of the staff who were present managed to protect the buildings until help arrived. A call was put in to the officer commanding the Work Point barracks, ten miles away, and General Ashton rushed a couple of hundred men out and in a few hours the fire was surrounded and under control. A ghastly-

looking western slope of some 40 or 50 acres is the final outcome and doubtless seeing conditions will suffer in consequence.

Recognizing the inadequacy of the present fire protection, the Public Works Department is spending considerable money in bringing the city water from its present terminus, a couple of miles distant, and erecting a large reservoir on the top of the hill by which it is hoped to avoid a recurrence of August last. The contract has also been let for clearing off the burned-over area and a number of other improvements are under way as well.

The Newtonian mirror, aluminized at Pasadena through the kindness of Dr. Adams, proved so satisfactory that the 19-inch secondary was also sent there towards the end of November to be aluminized also. Up to the present, January 9, it has not been returned. Its absence is particularly felt when a Nova is in the sky.

Dr. Frank S. Hogg of our staff resigned to accept a lectureship in the University of Toronto, and with Mrs. Hogg and "Sally" left for his new field of labour on December 16. The staff took note of his leaving by presenting him with a beautiful drawing set. The local centre of the Astronomical Society also tendered a complimentary dinner to Dr. and Mrs. Hogg a few evenings before their departure. Our loss is Toronto's gain.

Dr. J. S. Plaskett, who has been director of the observatory since its beginning in 1917, made application to the Department in September to be granted retirement, effective January 31, 1934. He plans to spend six months in England and with Mrs. Plaskett and Stuart leaves on January 19, going by way of the Panama canal. Dr. Plaskett's name appeared in the New Year's list of honours, being made a C.B.E. (Commander of the British Empire). The Canadian Club of the city tendered him a complimentary dinner on January 11, at which he spoke briefly of his recent researches. The staff also took occasion to tender its best wishes for a pleasant future and presented him with a beautiful desk set. A fuller notice of his work will appear later.

The assistant director, your scribe, was called to Ottawa in late November for consultation with the department regarding reorganization consequent upon the retirement of Dr. Plaskett. Returning by way of Toronto, he spent a pleasant day renewing acquaintances at the university. W. E. H.

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

Systematic Meteor Observing

Although more meteors are visible at the time of the annual showers, such as the Perseids and Geminids, it must not be forgotten that meteors are visible on any night in the year and that valuable work can be done by the amateur in observing these so-called sporadic meteors. For equal observing periods approximately twice as many meteors will be seen during the second half of the year as during the first half, and about twice as many during the hours after midnight as during those before. Though the next co-operative programme planned is for the Perseid observations in August, the writer is always glad to receive counts or plots of meteors made at any time during the year. The exact period over which the observations were made, the date, place, and condition of the sky, and also the part of the sky observed, should always be noted. Without setting aside definite periods for meteor observation, however, the amateur astronomer can do his bit by carefully recording all meteors seen by chance during the course of the year. In particular, where much telescopic observing is done, one should always have some meteor maps at hand so that any meteors seen may be plotted at once. The

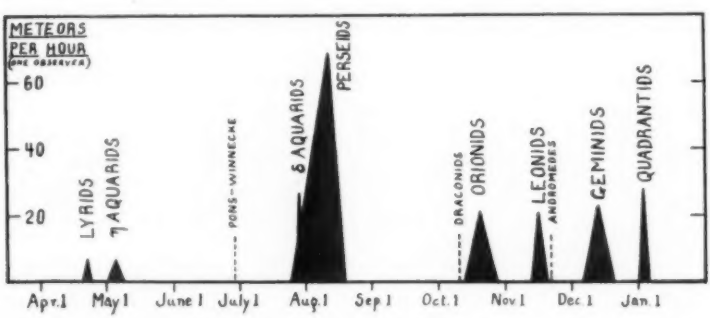

Figure 1.—The average strength and duration of the chief meteoric showers of the year (after Olivier).

writer will be glad to supply maps for this purpose to those who think they may have opportunity to use them.

The chief showers of the year have been listed by Prof. C. P. Olivier, president of the American Meteor Society, in Bulletin No. 15 of that society. For the convenience of the readers of the JOURNAL this table is reproduced below and illustrated graphically in Figure 1. As mentioned last month the Perseids and Geminids have proved to be the most favourable yearly showers for meteor photography owing to the numbers of bright meteors accompanying them.

CHIEF METEORIC SHOWERS OF THE YEAR

Shower	Duration in days	Date of maximum (evening date)	Hourly number of all meteors on this date
Quadrantids	4	Jan. 2	28
Lyrids	4	Apr. 21	7
Eta Aquarids	8	May 4	7
Pons-Winnecke		June 28	(seen in 1916)
Delta Aquarids	3	July 28	27
Perseids	25	Aug. 11	69
Draconids		Oct. 9	(seen in 1933)
Orionids	14	Oct. 19	21
Leonids	7	Nov. 15	21
Andromedes	2	Nov. 20	(last seen 1899)
Geminids	14	Dec. 12	23

ERRORS IN ALTITUDE ESTIMATES

In the reduction of fireball data one frequently has to deal with altitudes estimated by the layman. It is a recognized fact that these are subject to large accidental and systematic errors and for this reason some investigators have suggested disregarding them entirely and relying only on altitudes determined in some more accurate manner. Should this be done, however, a great amount of valuable observational material might be wasted, while in some cases rough visual estimates of altitude are all that are available.

To obtain a rough idea of the errors to be expected in visual estimates of altitude the writer had members of several classes in elementary astronomy estimate altitudes of various stars. These

estimates were made individually with no collaboration or discussion among the students. The students had had no previous training in constellation observation and attention was kept away from the northern sky to avoid any influence Polaris might have on the results. Estimates on two different nights were made on 24 stars by 36 students. The total number of individual estimates made was about 430. There was an almost constant tendency to overestimate altitude by 8 or 9 degrees. The difference between mean estimated altitude and true altitude is plotted in Figure 2. The mean probable

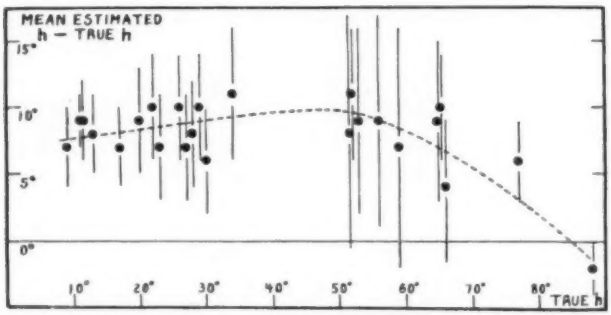

FIGURE 2.—The mean over-estimate of altitude plotted against true altitude. The vertical lines represent the mean probable error of an individual estimate.

error for an individual estimate was between 4 and 5 degrees and was greater for the higher altitudes. A few stars in the northern sky showed over-estimates of 2 to 4 degrees, indicating the effect of Polaris on the estimates. The observations were made from the roof of the laboratory which gave a fairly clear horizon. Over-estimates for low altitudes might not be quite as great for observers on the ground. It would seem that an estimate of altitude made without reference to other objects in the sky should generally be reduced by about 8 degrees and considered to have a probable error in the neighbourhood of 5 degrees.

P. M. M.

REVIEW OF PUBLICATIONS

A Key to the Stars, by R. van der R. Woolley. 142 pages, 5x7 in., 8 plates, with star maps and other figures. London (and Toronto): Blackie, 1934. Price 5 sh.

This is still another welcome book on elementary astronomy written by a competent person, Dr. Woolley being Chief Assistant at the Royal Observatory, Greenwich.

The preface begins thus:

> Most professional scientists, judged by their ready criticisms of popular book writing, have views of their own about how a popular book should be written. The author of this one has had a chance to air his views in the exacting field of practice, and he has tried to live up to what he used to preach: that the latest developments, the fields in which speculation is still rife and knowledge has not been won for certain, are less suitable for popular exposition than the demonstrable results which are well studied and well known and which partake of the character of the laws of Nature.

With this view the present writer is in agreement. A wrong impression of the astronomer's work is sometimes given by freely stating deductions which are based on hypotheses not fully verified and which a few years later will be discarded.

However there are some things in this book which are open to criticism. It seems that there are too many ideas and terms introduced without definition, and in some cases the definitions are not clear. As an example consider Right Ascension. In the index to the book there is one reference to it, that on page 6. Here the name is simply introduced, "to which we shall refer later". Then on page 16, after explaining terrestrial longitude, is the statement, "Astronomical longitude is called Right Ascension and instead of being measured in degrees like terrestrial longitude, it is given in hours and minutes, the twenty-four hours of the sidereal day being spread out round the sky." Then on page 54 we have, "the right ascension being the angle between the line joining the earth to the star and a fixed direction, the direction of the equinox". Again, the definition of a star of the first (or any other) magnitude, is not that generally

accepted. Aldebaran, Pollux, Spica, Regulus and Castor are stated to be of the second magnitude. The terms revolution and rotation are usually sharply distinguished by the astronomer, but on page 102 we have "two stars rotating round a common centre of gravity"; also, on page 46, in a reference to the motion of Jupiter's satellites by which the speed of light was determined, we have: "The astronomer Römer noticed that when he observed their rates of rotation at a time when Jupiter was close to the earth, &c." To some other matters exception might be taken but they must not be allowed to obscure the good features of the book. There are many interesting things in it which are not given in most works on astronomy, and the intelligent reader will find much to arouse his interest and to cause him to think.

C. A. C.

Men, Mirrors, and Stars, by G. Edward Pendray. Pages, 350 and 31 plates, 5¼×7¾ in. N.Y., Funk and Wagnalls, 1935. Price $3.00.

This is a very attractive book. It is largely historical and the topics treated are full of scientific and human interest. The author is science editor of *The Literary Digest* and also president of the American Rocket Society. He is well informed on astronomical matters and does not avoid technical questions but always discusses them in an easy lucid style. The continual introduction of characteristic little personal details when describing astronomical investigations or various mechanical projects makes the book pleasant to dip into for a few minutes at almost any page.

The book is divided into three parts. The first part deals with the progress of astronomy before the invention of the telescope, the discovery and evolution of the telescope and the use of the camera and the spectroscope. In the second part modern telescopes are described, with interesting information regarding light, glassmaking, good seeing, filar micrometers, interferometers, etc. Part three is entitled, "Modern men and modern mirrors," and tells in a graphic way how telescopes came to America and how they have grown to their present impressive numbers and dimensions. It would be hard to compress into one hundred pages more interesting information and it is brought right up to the present.

There are two appendices. In the first is given a list of the world's largest telescopes and where they are located. The second contains information regarding the chief modern observatories in North America and the southern hemisphere. Then follows a nine-page index which is very good but which might be made fuller with advantage. C. A. C.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Sky-glow from Large Cities.

Mr. David W. Rosebrugh, of Poughkeepsie, N.Y., (formerly of Toronto) in a personal letter gives some interesting observations of the glow in the sky from distant cities, which I take the liberty of printing.

I have thought for many years that it should occasionally be possible to see the glow of the lights of a large city like New York in the sky for many miles. Of course we have all seen such phenomena from distances of perhaps 15 or 20 miles but the last time I saw this manifestation it was more spectacular than I had ever seen it before.

I spent the evening of December 31, 1934, with some friends at Sharon, Connecticut, only a few miles from the north-west corner of this state. Their house is situated on a low plateau about 1000 feet above sea level, with low mountains in many directions rising about 1000 feet higher. The day had been cold and clear until about sunset, but by 6 p.m. the sky had become covered by a cirrus haze and in parts by cirro-stratus clouds.

As I looked to the southwards I was able to see the glow of New York City in the sky at an elevation of perhaps three degrees above the horizon. I find by the map that this was a distance of upwards of 80 miles. Apparently the under side of the clouds at a height of some five miles in the air was illuminated by the lights of the city and it was clear enough under the clouds to see this glow for 80 miles.

At this time I did not notice the glow of any other city in the sky. However about 10 p.m. the glow of New York had disappeared but glows were visible over the cities of Poughkeepsie, some 27 miles to the west; Hudson, N.Y., some 31 miles to the north-west, and Hartford about 45 miles to the east. I did not notice the glow of Pittsfield or Springfield, Mass., but these were over the shoulder of a low mountain.

About two hours later it began to snow and snowed some six inches by morning. All New Year's Day was cloudy and mild.

Home-built Instruments.

While on a pleasant visit to Montreal recently the present writer had the pleasure of meeting the indefatigable amateur, Mr. John Forbes, and was shown by him a letter which he had recently received from Mr. Will Hay, who is well known on the stage in England. Mr. Hay is a F.R.A.S and possesses a 6-inch Cooke refractor with a 5-inch Zeiss camera. In addition he has a good machine shop in which he constructed a chronograph electrically driven and controlled by a Synchronome clock, also a blink microscope which, he states, is the only one at present in the British Isles. Mr. Hay also knows how to use his telescope, one of his discoveries being a spot on Saturn in 1933. Mr. Hay must get much pleasure from his noble hobby and he has our congratulations.

These Degenerate Days!

The lamentable economic conditions now prevailing in various countries, and the objectionable commercial practices which are being revealed during these years of financial depression; the tales of crime continually reported in our daily newspapers; and the charge sometimes made that our young people are losing the moral stability of their fathers and forefathers; have led some persons to believe that we have fallen upon evil times. Evidence to the contrary is easily available in histories dealing with the condition of the people a century or more ago, or even in works of fiction which set their scenes in those older days. These thoughts were suggested by a book catalogue received a few days ago. One of the books advertised was:

> Causes of the Decay of Christian Piety. *An Impartial Survey of the Ruines of Christian Religion undermined by Unchristian Practice* by the Author of *The Whole Duty of Man* (1667).

More than two hundred and fifty years have elapsed since this book was written, and who shall say that the moral and religious conditions have not improved during that interval?

C. A. C.

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General Index to the TRANSACTIONS of the R.A.S.C., 1890-1905, and the JOURNAL, Vols. 1 to 25, 1907-31.

Compiled by W. E. Harper, Assistant Director, Dominion Astrophysical Observatory, Victoria, B.C.

Pages, 122; Price, $1.00, postage 5c. extra.

New Materials for the History of Man—The Festival of the Dead, by R. G. Haliburton.

This is a research into the Year of the Pleiades, first published at Halifax, N.S., in 1863; reprinted by the R.A.S.C. in 1920.

Pages, 126; Price, $1.00, postage 5c. extra.

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